## NASA/TM-2000-209891, Vol. 226



# Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and Sara K. Conrad, Editors

Volume 226 BOREAS TGB-3 CH<sub>4</sub> and CO<sub>2</sub> Chamber Flux Data over NSA Upland Sites

K. Savage and T.R. Moore

National Aeronautics and Space Administration

**Goddard Space Flight Center** Greenbelt, Maryland 20771

#### The NASA STI Program Office ... in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA Scientific and Technical Information (STI) Program Office plays a key part in helping NASA maintain this important role.

The NASA STI Program Office is operated by Langley Research Center, the lead center for NASA's scientific and technical information. The NASA STI Program Office provides access to the NASA STI Database, the largest collection of aeronautical and space science STI in the world. The Program Office is also NASA's institutional mechanism for disseminating the results of its research and development activities. These results are published by NASA in the NASA STI Report Series, which includes the following report types:

- TECHNICAL PUBLICATION. Reports of completed research or a major significant phase of research that present the results of NASA programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA's counterpart of peer-reviewed formal professional papers but has less stringent limitations on manuscript length and extent of graphic presentations.
- TECHNICAL MEMORANDUM. Scientific and technical findings that are preliminary or of specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.
- CONTRACTOR REPORT. Scientific and technical findings by NASA-sponsored contractors and grantees.

- CONFERENCE PUBLICATION. Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or cosponsored by NASA.
- SPECIAL PUBLICATION. Scientific, technical, or historical information from NASA programs, projects, and mission, often concerned with subjects having substantial public interest.
- TECHNICAL TRANSLATION.
   English-language translations of foreign scientific and technical material pertinent to NASA's mission.

Specialized services that complement the STI Program Office's diverse offerings include creating custom thesauri, building customized databases, organizing and publishing research results . . . even providing videos.

For more information about the NASA STI Program Office, see the following:

- Access the NASA STI Program Home Page at http://www.sti.nasa.gov/STI-homepage.html
- E-mail your question via the Internet to help@sti.nasa.gov
- Fax your question to the NASA Access Help Desk at (301) 621-0134
- Telephone the NASA Access Help Desk at (301) 621-0390
- Write to:
   NASA Access Help Desk
   NASA Center for AeroSpace Information
   7121 Standard Drive

Hanover, MD 21076-1320

## NASA/TM-2000-209891, Vol. 226



# Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and Sara K. Conrad, Editors

Volume 226
BOREAS TGB-1 CH<sub>4</sub> and CO<sub>2</sub>
Chamber Flux Data over NSA
Upland Sites

Kathleen Savage, Woods Hole Research Center, Massachusetts Tim R. Moore, McGill University, Montreal, Quebec

National Aeronautics and Space Administration

**Goddard Space Flight Center** Greenbelt, Maryland 20771

	Available from:	
NIACA Contourfour Armong units of		Notional Tasks: -1 Informed C
NASA Center for AeroSpace Information		National Technical Information Service
7121 Standard Drive		5285 Port Royal Road
Hanover, MD 21076-1320		Springfield, VA 22161
Drica Codo: A17		Dring Code, A10
Price Code: A17		Price Code: A10

## BOREAS TGB-3 CH<sub>4</sub> and CO<sub>2</sub> Chamber Flux Data over NSA Upland

Kathleen Savage, Tim R. Moore

## **Summary**

The BOREAS TGB-3 team collected methane and carbon dioxide (CH<sub>4</sub>, CO<sub>2</sub>) chamber flux measurements at the NSA Fen, OBS, YJP, and auxiliary sites along Gillam Road and the 1989 burn site. Gas samples were extracted from chambers and analyzed at the NSA lab facility approximately every 7 days during May to September 1994 and June to October 1996. The data are provided in tabular ASCII files.

## **Table of Contents**

- 1) Data Set Overview
- 2) Investigator(s)
- 3) Theory of Measurements
- 4) Equipment
- 5) Data Acquisition Methods
- 6) Observations
- 7) Data Description
- 8) Data Organization
- 9) Data Manipulations
- 10) Errors
- 11) Notes
- 12) Application of the Data Set
- 13) Future Modifications and Plans
- 14) Software
- 15) Data Access
- 16) Output Products and Availability
- 17) References
- 18) Glossary of Terms
- 19) List of Acronyms
- 20) Document Information

#### 1. Data Set Overview

#### 1.1 Data Set Identification

BOREAS TGB-03 CH<sub>4</sub> and CO<sub>2</sub> Chamber Flux Data over NSA Upland Sites

#### 1.2 Data Set Introduction

The Trace Gas Biogeochemistry (TGB)-03 team took chamber flux measurements at upland sites in the BOReal Ecosystem Atmosphere Study (BOREAS) Northern Study Area (NSA) from late May to early September 1994 and early June to late October 1996.

## 1.3 Objective/Purpose

The objectives of these measurements were:

- To examine the trace gas exchange between the atmosphere and the boreal upland soils.
- To identify environmental controls on CH<sub>4</sub> and CO<sub>2</sub> flux and the spatial and temporal variability associated with those controls in order to improve the process models that describe exchanges of trace gases between the boreal ecosystem and the atmosphere.

## 1.4 Summary of Parameters

In the 1994 sampling season, CH<sub>4</sub> and CO<sub>2</sub> chamber flux measurements were taken from 11 sites. These sites were designated as 1989 burn moss, 1989 burn spruce, palsa moss, palsa birch, Gillam aspen, Gillam pine, Gillam spruce, Young Jack Pine (YJP) wet, YJP dry, Old Black Spruce (OBS) aspen, OBS spruce.

In the 1996 sampling season, CH<sub>4</sub> and CO<sub>2</sub> chamber fluxes were measured at YJP wet, YJP dry, OBS aspen, OBS spruce, Old Jack Pine (OJP) moss, OJP aspen, and OJP pine (note OJP sites sampled by Patrick Crill in 1994).

#### 1.5 Discussion

In 1994, CH<sub>4</sub> and CO<sub>2</sub> chamber flux measurements were taken at the 11 sites within the NSA to determine the soil surface exchange rate of CH<sub>4</sub> and CO<sub>2</sub> at these locations. The locations represent both a hydraulic and disturbance gradient. The sampling collars were installed in the spring of 1994 by the McGill researchers (TGB-03), and measurements of CH<sub>4</sub> and CO<sub>2</sub> flux were made during and between the 1994 and 1996 Intensive Field Campaigns (IFCs).

#### 1.6 Related Data Sets

BOREAS TGB-01 NSA CH4 and CO2 Chamber Flux Data BOREAS TGB-01 CH4 Concentration and Flux Data from NSA Tower Sites BOREAS TGB-01/TGB-03 CH4 Chamber Flux Data over the NSA Fen

## 2. Investigator(s)

## 2.1 Investigator(s) Name and Title

Dr. Tim R. Moore Professor McGill University

Kathleen Savage McGill University

#### 2.2 Title of Investigation

Environmental Controls on Methane Consumption and Carbon Dioxide Emissions in Upland Boreal Forest Soil

#### 2.3 Contact Information

#### Contact 1:

Dr. Tim R. Moore Geography Department McGill University 805 Sherbrooke St. W. Montreal, Quebec H3A 2K6 Canada (514) 398-4961 (514) 398-7437 (fax) moore@felix.geog.mcgill.ca Contact 2:

Kathleen Savage Research Assistant Woods Hole Research Center P.O. Box 296 Woods Hole, MA 02543, U.S.A (508) 540-9900 ext. 142 (508) 540-2578 (fax) savage@whrc.org

Contact 3:

Jeffrey A. Newcomer Raytheon ITSS Code 923 NASA GSFC Greenbelt, MD 20771 (301) 286-7858 (301) 286-0239 (fax) Jeffrey.Newcomer@gsfc.nasa.gov

## 3. Theory of Measurements

Chamber fluxes measure the changes in mixing ratio of trace gases (CH<sub>4</sub> and CO<sub>2</sub>) in a closed headspace over a period of time. This headspace is isolated from the atmosphere; therefore, the exchange of material between the covered soil and the headspace can be quantified.

## 4. Equipment

## 4.1 Sensor/Instrument Description

The  $CH_4$  and  $CO_2$  flux measurements were taken with PVC collars (26 cm in diameter) and chambers made from polycarbonate bottles (26 cm in diameter; 40 cm tall; area of exposure 0.053 m<sup>2</sup>; Moore and Roulet, 1991). Bottles were covered with aluminum foil to reduce heating. The neck of each bottle was sealed with a rubber stopper that contained a glass tube with a rubber septum with a 1-m length of Tygon tubing attached to the top to minimize disturbance. Syringes were made of polypropylene.

CH<sub>4</sub> and CO<sub>2</sub> were quantified with a Shimadzu 14A Gas Chromatograph (GC) equipped with a flame ionization detector (FID) for CH<sub>4</sub> and thermal conductivity Detector (TCD) for CO<sub>2</sub>. A HayeSepQ column was used, the GC temperature was set at 40 °C, and ultra-pure (99.999%) N<sub>2</sub> was used as the carrier gas flowing at 30 mL/min. The detectors were operated at 125 °C. Analog signals (0-1 V) from the detectors were digitized at 10 Hz with a Hewlett Packard (HP) 35000D A/D board and quantified and logged using HP ChemStation software.

Chamber fluxes were accomplished with aluminum chambers manufactured at the University of New Hampshire (UNH) and designed by Patrick Crill.

### **4.1.1 Collection Environment**

The chamber fluxes were collected under ambient environmental conditions.

#### 4.1.2 Source/Platform

Ground.

## 4.1.3 Source/Platform Mission Objectives

The ground supported the collars and chambers.

## 4.1.4 Key Variables

The key variable measured during the sampling period was CH<sub>4</sub> and CO<sub>2</sub> flux. Soil temperature, moisture, and soil gas profile concentrations were also measured.

## 4.1.5 Principles of Operation

The Shimadzu GC-14A is equipped with a FID and a TCD. The FID is used to detect CH<sub>4</sub>; the TCD is used to detect CO<sub>2</sub>. The FID uses a hydrogen flame in an air atmosphere to burn components as they exit the column. In the flame, carbon-carbon bonds are fragmented so that various organic ions and free electrons exist. Application of a voltage across a collector electrode over the flame causes an ion current to flow that is amplified and then measured as the output signal. The TCD detects CO<sub>2</sub> by passing a sample in a helium carrier gas past metallic filaments with current flowing through them. The sample components with lower thermal conductivity than the helium carrier gas raise the filament temperature when they pass through. The signal output from the TCD is a measurement of the change in filament resistance caused by the temperature rise. The signal output from both the FID and TCD is for a data processor, integrator, recorder, or computer (Instruction Manual: GC-14A; Shimadzu Corporation, Kyoto, Japan).

## 4.1.6 Sensor/Instrument Measurement Geometry

Not applicable.

## 4.1.7 Manufacturer of Sensor/Instrument

The investigator manufactured collar and chambers.

Manufacturer of GC-14A FID/TCD and GC-MINI2: Shimadzu Scientific Instruments, Inc. 7102 Riverwood Drive Columbia, MD 21046 (410) 381-1227

#### 4.2 Calibration

## 4.2.1 Specifications

Analyses were conducted with a Shimadzu GC with a FID (FID-GC) using a Porapak Q column. Nitrogen was used as the carrier gas, and  $CH_4$  standards of 2.349 ppmv were used to calibrate. Precision of the analysis (standard deviation as percent of the mean of 10-15 daily repetitions of the standard) was less than 1% of the standards. Fluxes between 0.1 and -0.1 mg/m²/d were not detectable.

Signal peaks from the detectors were quantified with working standards calibrated against Canadian Atmospheric Environment Services (AES) certified primary standards acquired by the BOREAS project and a  $\rm CO_2/CH_4$  standard of Niwot Ridge air prepared by the National Oceanic and Atmospheric Administration (NOAA) Climate Monitoring and Diagnostics Laboratory (CMDL). Uncertainty in the standards' analyses on a given day ranged from 0.1 to 0.2%.

#### **4.2.1.1** Tolerance

The sensitivity of the TCD is approximately 6,000 mV mL/mg. The FID's maximum sensitivity is 3 x 10-12 g/s for diphenyl.

## 4.2.2 Frequency of Calibration

The instrument is calibrated on a daily basis. Standards are run generally before and after samples on a given day of analysis.

#### 4.2.3 Other Calibration Information

None given.

## 5. Data Acquisition Methods

A total of 66 PVC collars were placed along the moisture and disturbance gradients in the NSA and sampled in 1994. CH<sub>4</sub> and CO<sub>2</sub> were sampled at each of the collars once a week from early May through mid-September 1994 using a static chamber technique (Crill et al., 1988). Water was added to the groove in each collar before inserting the chamber in order to make an airtight seal. Air samples were obtained from each chamber by inserting a polypropylene syringe into the Tygon tubing equipped with a three-way stopcock and pumping the piston four or five times to mix air in the chamber before a 60-mL sample was drawn. A 10-mL sample was taken from the 60-mL syringe using the three-way stopcock. Four 10-mL samples were taken at 5-minute intervals over a 20-minute period. Samples were returned to a laboratory in Thompson and analyzed for CH<sub>4</sub> and CO<sub>2</sub> within 4-6 hours of collection.

## 6. Observations

## **6.1 Data Notes**

None given.

#### **6.2 Field Notes**

None given.

## 7. Data Description

## 7.1 Spatial Characteristics

## 7.1.1 Spatial Coverage

The North American Datum of 1983 (NAD83) coordinates for the sites are:

Burn Moss:	BM:	55.906° N,	98.947° W
Burn Spruce:	BS:	55.906° N,	98.949° W
Palsa Moss:	PM:	55.902° N,	98.418° W
Old Black Spruce, spruce stand:	OBSS:	55.902° N,	97.497° W
Gillam Road Spruce:	GS:	55.904° N,	97.706° W
Gillam Road Pine:	GP:	55.901° N,	97.709° W
Old Black Spruce, aspen stand:	OBSA:	55.906° N,	98.5° W
Gillam Road Aspen:	GA:	53.901° N,	97.712° W
Palsa Bog:	PB:	55.902° N,	98.419° W
Fen Tower site:	FEN:	55.91481° N,	98.42072° W
Old Black Spruce Tower site:	OBS:	55.88007° N,	98.48139° W
Old Jack Pine Tower site:	OJP:	55.92842° N,	98.62396° W
Young Jack Pine Tower site:	YJP:	55.89575° N,	98.28706° W
Young Jack Pine dry site:	YJPD:	55.896° N,	98.298° W
Young Jack Pine wet site:	YJPW:	55.883° N,	98.286° W

## 7.1.2 Spatial Coverage Map

Not available.

#### 7.1.3 Spatial Resolution

These are point source data made from the enclosed areas.

## 7.1.4 Projection

Not applicable.

## 7.1.5 Grid Description

Not applicable.

## 7.2 Temporal Characteristics

## 7.2.1 Temporal Coverage

CH<sub>4</sub> and CO<sub>2</sub> flux, temperature, moisture, and profile concentration measurements were made from mid-May through mid-September 1994.

## 7.2.2 Temporal Coverage Map

Not available.

## 7.2.3 Temporal Resolution

CH<sub>4</sub> and CO<sub>2</sub> flux measurements were made once a week at each of the 66 collars throughout the season.

## 7.3 Data Characteristics

## 7.3.1 Parameter/Variable

The parameters contained in the data files on the CD-ROM are:

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
COLLAR_ID
AIR_TEMP
CO2_FLUX
CH4_FLUX
CRTFCN_CODE
REVISION_DATE

## 7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files on the CD-ROM are:

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.

DATE_OBS	The date on which the data were collected.			
COLLAR_ID	A TGB designation for the chamber collar sites.			
AIR_TEMP	The air temperature.			
CO2_FLUX	Carbon Dioxide flux.			
CH4_FLUX	Methane flux.			
CRTFCN_CODE	The BOREAS certification level of the data.			
	Examples are CPI (Checked by PI), CGR (Certified			
	by Group), PRE (Preliminary), and CPI-??? (CPI			
	but questionable).			
REVISION_DATE	The most recent date when the information in the			
	referenced data base table record was revised.			

## 7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files on the CD-ROM are:

Column Name	Units
SITE NAME	[none]
<del>_</del>	
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
COLLAR_ID	[none]
AIR_TEMP	[degrees Celsius]
CO2_FLUX	[micromoles][meter^-2][second^-1]
CH4_FLUX	<pre>[micromoles][meter^-2][second^-1]</pre>
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

## 7.3.4 Data Source

The sources of the parameter values contained in the data files on the CD-ROM are:

Column Name	Data Source
SITE_NAME	Assigned by BORIS
SUB_SITE	Assigned by BORIS
DATE_OBS	Investigator
COLLAR_ID	Investigator
AIR_TEMP	[PLEASE COMPLETE]
CO2_FLUX	Shimadzu GC
CH4_FLUX	Shimadzu GC
CRTFCN_CODE	Assigned by BORIS
REVISION_DATE	Assigned by BORIS

## 7.3.5 Data Range

The following table gives information about the parameter values found in the data files on the CD-ROM.

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	NSA-9BS-T03BS	NSA-YJP-T03JP	None	None	None	None
SUB_SITE	TGB03-FLX01	TGB03-FYJPW	None	None	None	None
DATE_OBS	16-MAY-94	22-OCT-96	None	None	None	None
COLLAR_ID	BM-01	YJPW-06	None	None	None	None
AIR_TEMP	-1	33	None	None	None	Blank

CO2_FLUX CH4_FLUX CRTFCN_CODE REVISION_DATE	-39.547454 00683 CPI 14-APR-97	.10096956 CPI	-999 None	-888 None	None None None	
Minimum Data Value Maximum Data Value Missng Data Value	The maximum v The value tha indicate that	ralue found in the state of the	the colum ssing dat s made to	n. a. This determ	ine the	to
Unrel Data Value	The value tha to indicate a parameter val	tue, but the attention in attempt was rate, but the value, but the value.	reliable made to d lue was d	data. etermin eemed t	This is e the	used
Below Detect Limit	The value that instruments dindicate that parameter valuate that		rameter vs. This made to alysis pe	alues b is used determ rsonnel	to ine the determi	
Data Not Cllctd	This value in determine the indicates that not identical	dicates that no e parameter value t BORIS combine data sets into icular science	o attemptue. Thised severa	usuall l simil e data	Y ar but	le
Blank Indicates N/A Indicates None Indicates	that the value i	s not applicab	le to the	respec	tive col	

#### 7.4 Sample Data Record

The following are wrapped versions of sample data records from a selected file on the CD-ROM:

```
SITE_NAME,SUB_SITE,DATE_OBS,COLLAR_ID,AIR_TEMP,CO2_FLUX,CH4_FLUX,CRTFCN_CODE,REVISION_DATE
'NSA-9BS-T03BS','TGB03-FLXBM',07-JUN-94,'BM-04',84.834838, -.00242,'CPI',
16-APR-98
'NSA-9BS-T03BS','TGB03-FLXBM',07-JUN-94,'BM-05',9.04900463,0,'CPI',16-APR-98
```

## 8. Data Organization

## 8.1 Data Granularity

The smallest set of CH<sub>4</sub> and CO<sub>2</sub> flux measurements tracked by BOREAS was the data collected at a given site on a given day.

## 8.2 Data Format(s)

The Compact Disk-Read-Only Memory (CD-ROM) files contain American Standard Code for Information Interchange (ASCII) numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe marks. There are no spaces between the fields.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

## 9. Data Manipulations

#### 9.1 Formulae

## 9.1.1 Derivation Techniques and Algorithms

 $R_f = C_{std} \ / \ A_{std}$ 

 $C_s = R_f * A_s$ 

 $R_f$  = Response factor

 $A_{std}$  = Standard peak area

 $C_{std}$  = Concentration of the standard

 $C_s$  = Concentration of the sample

 $A_s$  = Peak area of sample

CH<sub>4</sub> concentrations were calculated from the average of 10 peak areas of known CH<sub>4</sub> standards. The response factor was calculated as the concentration of the known standard divided by the average of 10 standard peak areas. The peak area of the unknown sample was multiplied by the response factor.

The flux calculations were made by fitting a regression curve to the time series of CH<sub>4</sub> concentrations. The flux rate of a gas is calculated using the following equation:

Flux(mg/m<sup>2</sup>/d) = ppmv/min \* (P/R\*g/mol of the gas) \* (1/T)\*
$$V_c/A_c$$
 \* (1000mg/g\*1440min/d)

where: P = pressure in atmospheres

 $R = 8.2054 \times 10^{-5} \text{ m}^3 \text{ atm/mol/K}$ 

gases:  $CH_4 = 16 \text{ g/mol}$ 

 $T = degrees K of the chamber V_c = chamber volume in m<sup>3</sup>$ 

 $A_c$  = chamber area in m<sup>2</sup>

 $V_c = ((E/100 \times 0.047 \times 1000) + V_t)$ 

 $V_c$  = volume of the chamber

 $V_t$  = volume of the top narrow part of chamber = 1.4

E = height of cylindrical part of chamber in cm

## 9.2 Data Processing Sequence

9.2.1 Processing Steps

The peak areas were taken directly from the HP ChemStation reports from the GC. They were entered into spreadsheets, and the concentrations were calculated using the formulas in Section 9.1. The spreadsheets then automatically calculated the flux using the formulas in Section 9.1.

The flux equation included the slope of the regression line of the five samples the height and volume of the chamber and air temperature (see above). Fluxes were calculated by linear regression of the concentration change in the five samples. If one sample deviated from the line, the flux was recalculated without the outlier. The correlation coefficient of the regression had to be significant to the 95% confidence limit for n=4 or 5 ( $r^2=0.95$  or 0.87); otherwise, the sample was rejected. Sites with ebullition were kept in the data set even if a large increase was observed between two of the samples as long as the correlation coefficient was still significant at p < 0.05.

## 9.2.2 Processing Changes

None given.

## 9.3 Calculations

Not applicable.

## 9.3.2 Calculated Variables

Refer to Section 9.1.1.

## 9.4 Graphs and Plots

None given.

## 10. Errors

#### 10.1 Sources of Error

Field sampling error could account for some error in the concentration of the syringe samples:

- Not flushing the sampling line from the chamber before sampling could cause dilution of the sample with air from the last sampling time.
- Not completely closing the syringes or allowing them to come open during transport will cause dilution from ambient air.

Errors such as these would have been written down in the lab/field books, and these data have been edited out. The analytical precision of the GCs is 0.2% for CH<sub>4</sub>.

## 10.2 Quality Assessment

#### 10.2.1 Data Validation by Source

Each flux measurement has been verified by checking the calculations in the spreadsheets and assessing the slope and intercept for the linear regression.

#### 10.2.2 Confidence Level/Accuracy Judgment

None given.

#### **10.2.3 Measurement Error for Parameters**

The analytical precision of the GCs is 0.2% for CH<sub>4</sub>.

#### 10.2.4 Additional Quality Assessments

None given.

## 10.2.5 Data Verification by Data Center

Data were examined for general consistency and clarity.

## 11. Notes

## 11.1 Limitations of the Data

The analytical precision of the GCs is 0.2% for CH<sub>4</sub>.

#### 11.2 Known Problems with the Data

None given.

## 11.3 Usage Guidance

None given.

#### 11.4 Other Relevant Information

None given.

## 12. Application of the Data Set

The chamber flux data can be used in connection with the tower flux data to determine the  $CH_4$  and  $CO_2$  exchange between the atmosphere and the boreal soils.

## 13. Future Modifications and Plans

None given.

## 14. Software

## 14.1 Software Description

None given.

#### 14.2 Software Access

None given.

## 15. Data Access

The TGB-03 upland flux data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

## 15.1 Contact Information

For BOREAS data and documentation please contact:

ORNL DAAC User Services Oak Ridge National Laboratory P.O. Box 2008 MS-6407 Oak Ridge, TN 37831-6407

Phone: (423) 241-3952 Fax: (423) 574-4665

E-mail: ornldaac@ornl.gov or ornl@eos.nasa.gov

#### 15.2 Data Center Identification

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics http://www-eosdis.ornl.gov/.

## 15.3 Procedures for Obtaining Data

Users may obtain data directly through the ORNL DAAC online search and order system [http://www-eosdis.ornl.gov/] and the anonymous FTP site [ftp://www-eosdis.ornl.gov/data/] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

#### 15.4 Data Center Status/Plans

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

## 16. Output Products and Availability

## 16.1 Tape Products

None.

## 16.2 Film Products

None.

#### 16.3 Other Products

These data are available on the BOREAS CD-ROM series.

## 17. References

## 17.1 Platform/Sensor/Instrument/Data Processing Documentation

None given.

#### 17.2 Journal Articles and Study Reports

Bubier, J.L., T.R. Moore, L. Bellisario, N.T. Comer, and P.M. Crill. 1995. Ecological controls on methane emissions from a northern peatland complex in the zone of discontinuous permafrost, Manitoba, Canada. Global Biogeochemical Cycles, 9 455-470.

Crill, P.M., K.B. Bartlett, R.C. Harriss, E. Gorham, E.S. Verry, D.I. Sebacher, L. Madzer, and W. Sanner, 1988. Methane flux from Minnesota peatlands, Global Biogeochemical Cycles, 2, 371-384.

Daubenmire, R.F. 1968. Plant communities: a textbook of plant synecology. Harper and Row, New York, NY.

Moore, T.R. and N.T. Roulet. 1991. A comparison of dynamic and static chambers for methane emission measurements from subarctic fens. Atmosphere-Ocean, 29, 102-109.

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. 2000. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM.

Roulet, N., S. Hardill, and N. Comer. 1991. Continuous measurement of the depth of water table (inundation) in wetlands with fluctuating surfaces. Hydrological Processes, 5, 399-403.

Roulet, N.T. 1991. Surface level and water table fluctuations in a subarctic fen. Arctic and Alpine Research, 23, 303-310.

Sellers, P. and F. Hall. 1994. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1994-3.0, NASA BOREAS Report (EXPLAN 94).

Sellers, P. and F. Hall. 1996. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1996-2.0, NASA BOREAS Report (EXPLAN 96).

Sellers, P., F. Hall, and K.F. Huemmrich. 1996. Boreal Ecosystem-Atmosphere Study: 1994 Operations. NASA BOREAS Report (OPS DOC 94).

Sellers, P., F. Hall, and K.F. Huemmrich. 1997. Boreal Ecosystem-Atmosphere Study: 1996 Operations. NASA BOREAS Report (OPS DOC 96).

Sellers, P., F. Hall, H. Margolis, B. Kelly, D. Baldocchi, G. den Hartog, J. Cihlar, M.G. Ryan, B. Goodison, P. Crill, K.J. Ranson, D. Lettenmaier, and D.E. Wickland. 1995. The boreal ecosystem-atmosphere study (BOREAS): an overview and early results from the 1994 field year. Bulletin of the American Meteorological Society. 76(9):1549-1577.

Sellers, P.J., F.G. Hall, R.D. Kelly, A. Black, D. Baldocchi, J. Berry, M. Ryan, K.J. Ranson, P.M. Crill, D.P. Lettenmaier, H. Margolis, J. Cihlar, J. Newcomer, D. Fitzjarrald, P.G. Jarvis, S.T. Gower, D. Halliwell, D. Williams, B. Goodison, D.E. Wickland, and F.E. Guertin. 1997. BOREAS in 1997: Experiment Overview, Scientific Results and Future Directions. Journal of Geophysical Research 102(D24): 28,731-28,770.

Sjors, H. 1950. On the relation between vegetation and electrolytes in Swedish mire waters. Oikos, 2, 241-258.

## **17.3** Archive/DBMS Usage Documentation None given.

## 18. Glossary of Terms

None given.

## 19. List of Acronyms

AES - Atmospheric Environment Services, Canada

ASCII - American Standard Code for Information Interchange

BOREAS - BOReal Ecosystem-Atmosphere Study

BORIS - BOREAS Information System
CD-ROM - Compact Disk-Read-Only Memory

CMDL - Climate Monitoring and Diagnostics Laboratory

DAAC - Distributed Active Archive Center

ECD - Electron Capture Detector
EOS - Earth Observing System

EOSDIS - EOS Data and Information System

FID - Flame Ionization Detector

GC - Gas Chromatograph

GIS - Geographic Information System
GSFC - Goddard Space Flight Center

HP - Hewlett Packard

HTML - HyperText Markup Language
IFC - Intensive Field Campaign
IRGA - Infrared Gas Analyzer

NAD83 - North American Datum of 1983

NASA - National Aeronautics and Space Administration NOAA - National Oceanic and Atmospheric Administration

NSA - Northern Study Area
OBS - Old Black Spruce
OJP - Old Jack Pine

ORNL - Oak Ridge National Laboratory PANP - Prince Albert National Park

SSA - Southern Study Area

TCD - Thermal Conductivity Detector
TGB - Trace Gas Biogeochemistry
UNH - University of New Hampshire
URL - Uniform Resource Locator

YJP - Young Jack Pine

## 20. Document Information

## 20.1 Document Revision Date

Written:

Last Updated: 11-Jun-1999

## 20.2 Document Review Date(s)

BORIS Review: 10-Mar-98

Science Review:

#### 20.3 Document ID

### 20.4 Citation

When using these data, please include the following acknowledgment as well as citations of relevant papers in Section 17.2:

The TGB-03 upland flux data were collected by Kathleen Savage and Tim Moore (McGill University). Their efforts in making these data are available are greatly appreciated.

If using data from the BOREAS CD-ROM series, also reference the data as:

Moore T.R. and K. Savage, "Environmental Controls on Methane Consumption and Carbon Dioxide Emissions in Upland Boreal Forest Soil." In Collected Data of The Boreal Ecosystem-Atmosphere Study. Eds. J. Newcomer, D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, CD-ROM, NASA, 2000.

#### Also, cite the BOREAS CD-ROM set as:

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM. NASA, 2000.

#### 20.5 Document Curator

#### 20.6 Document URL

## REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Artipaton, VA 22202-4302, and to the Office of Management and Budget Paperwork Beduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE November 2000	3. REPORT TYPE AND DATES COVERED Technical Memorandum		
	November 2000	Techni		
4. TITLE AND SUBTITLE			5. FUNDING NUMBERS	
Technical Report Series on the Bo	oreal Ecosystem-Atmosphere	e Study (BOREAS)		
BOREAS TGB-3 CH <sub>4</sub> and CO <sub>2</sub>	Chamber Flux Data over N	SA Upland Sites	923	
6. AUTHOR(S)			RTOP: 923-462-33-01	
Kathleen Savage and Tim R.	Moore			
Forrest G. Hall and Sara K. C				
7. PERFORMING ORGANIZATION NAME	E(S) AND ADDRESS (ES)		8. PEFORMING ORGANIZATION REPORT NUMBER	
Goddard Space Flight Center			KEI OKI NOMBEK	
Greenbelt, Maryland 20771			2000-03136-0	
9. SPONSORING / MONITORING AGE	NCY NAME(S) AND ADDRESS	(ES)	10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
Notional Association and Coope	A durinistantion			
National Aeronautics and Space	Administration		TM—2000–209891	
Washington, DC 20546-0001			Vol. 226	
11. SUPPLEMENTARY NOTES				
K. Savage: Woods Hole Rese	arch Center, Massachuse	tts; T.R. Moore: N	IcGill University, Montreal,	
Quebec; S.K. Conrad: Raythe	eon ITSS			
12a. DISTRIBUTION / AVAILABILITY STA	TEMENT		12b. DISTRIBUTION CODE	
Unclassified–Unlimited				
Subject Category: 43				
Report available from the NASA	A Center for AeroSpace Info	ormation		
7121 Standard Drive, Hanover,	•			
· ·	21070-1320. (301) 02	1-0370.		
13. ABSTRACT (Maximum 200 words)				

The BOREAS TGB-3 team collected methane and carbon dioxide (CH<sub>4</sub>, CO<sub>2</sub>) chamber flux measurements at the NSA Fen, OBS, YJP, and auxiliary sites along Gillam Road and the 1989 burn site. Gas samples were extracted from chambers and analyzed at the NSA lab facility approximately every 7 days during May to September 1994 and June to October 1996. The data are provided in tabular ASCII files.

14. SUBJECT TERMS BOREAS, trace gas biogeochemistry.			15. NUMBER OF PAGES	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL	